

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.2 BOOKCASES, SHELVING

6.5.2.1 BOOKSHELVES

Tall wood or metal shelving units frequently tip or overturn in earthquakes unless they are properly anchored.

TYPICAL CAUSES OF DAMAGE

- Tall, narrow shelving may tip, slide, overturn or collapse and the contents may spill. Overturned shelving may injure occupants and block doors or exits.
- Books, files, medical records may fall and get scrambled or damaged. Clean-up and reorganization of spilled items may take many hours or days and result in costly business interruption.

Damage Examples



Figure 6.5.2.1-1 Failure of poorly anchored wood and metal book shelves at the Lawrence Livermore Laboratory, Livermore, California (NGDC, 2009).



Figure 6.5.2.1-2 Failure of poorly anchored shelving; toggle bolt pulled out of gypsum board wall in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Wiss, Janney, Elstner Associates).



Figure 6.5.2.1-3 Bookcase overturned onto desk in the 1971 magnitude-6.6 San Fernando Earthquake (Photo courtesy of Degenkolb Engineers).

SEISMIC MITIGATION CONSIDERATIONS

- Permanent floor-supported shelving or storage cabinets over 6 ft tall must be designed as architectural components per ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2010). Bracing and anchorage for these units should be designed considering the weight of the unit and weight of shelved contents. The details shown in Figure 6.5.2.1-4 and 6.5.2.1-5 are for shelving units up to 6 feet tall.
- Bookcases and shelving should be anchored to an adjacent stud wall or concrete or masonry wall. For freestanding units, see Section 6.5.1.1 for recommended details for bracing units and tying back-to-back units together.
- See Section 6.5.6.1 for recommendations regarding edge restraints and arrangement for shelf-mounted items. Do not locate shelving adjacent to doors or exits if their failure would block the exit.
- Any connections to stud walls must engage the structural studs; do not rely on gypsum or plaster to support shelving. Stud walls and partitions may not have adequate lateral capacity to support many shelving units; engineering may be required. Where items are

anchored to heavy partitions, the bracing or anchorage of these partitions to the structure above must also be checked for adequacy considering the seismic loads imposed by all anchored items.

- Bookcase or cabinet anchorage can be located either outside or inside the unit as long as the attachment properly engages the “structural” studs. Where aesthetics are a concern, it may be preferable to locate the screws or clip angles on the inside of the unit. In a commercial setting where maintenance personnel or movers may need to verify the anchorage or relocate the unit periodically, it may be preferable to provide exterior anchorage that is readily visible.

Where rear wall of bookcase is wood or metal with mechanical connection to bookcase framing, unit may be fastened directly to wall studs with 1/4" sheet metal screw and washer, 2 minimum, top and bottom.

2 X 4 min. wood stud or 20 ga.
min. metal stud @ 24" oc max.
Verify that studs run full height
to floor above or are adequately
braced to structural framing

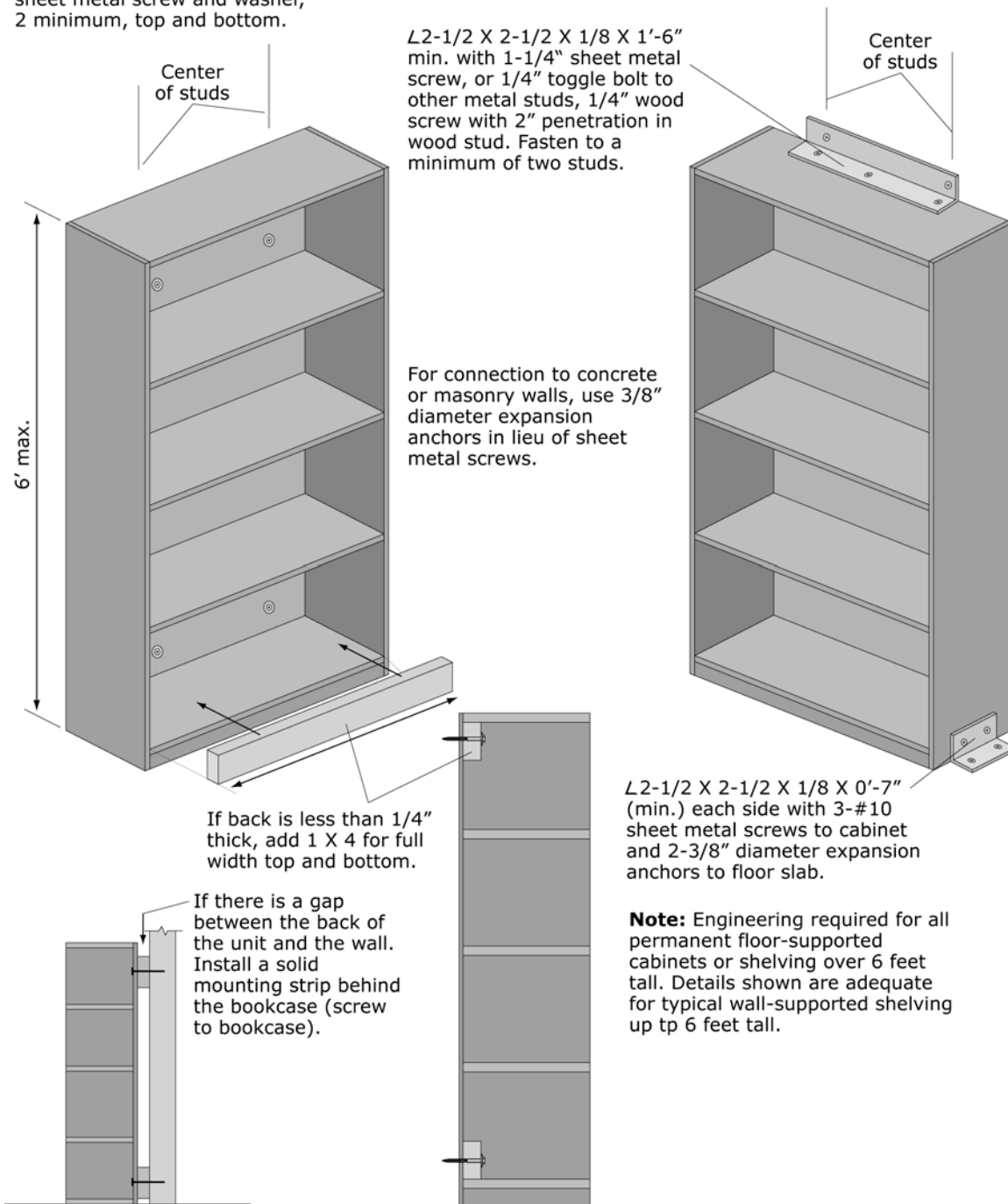
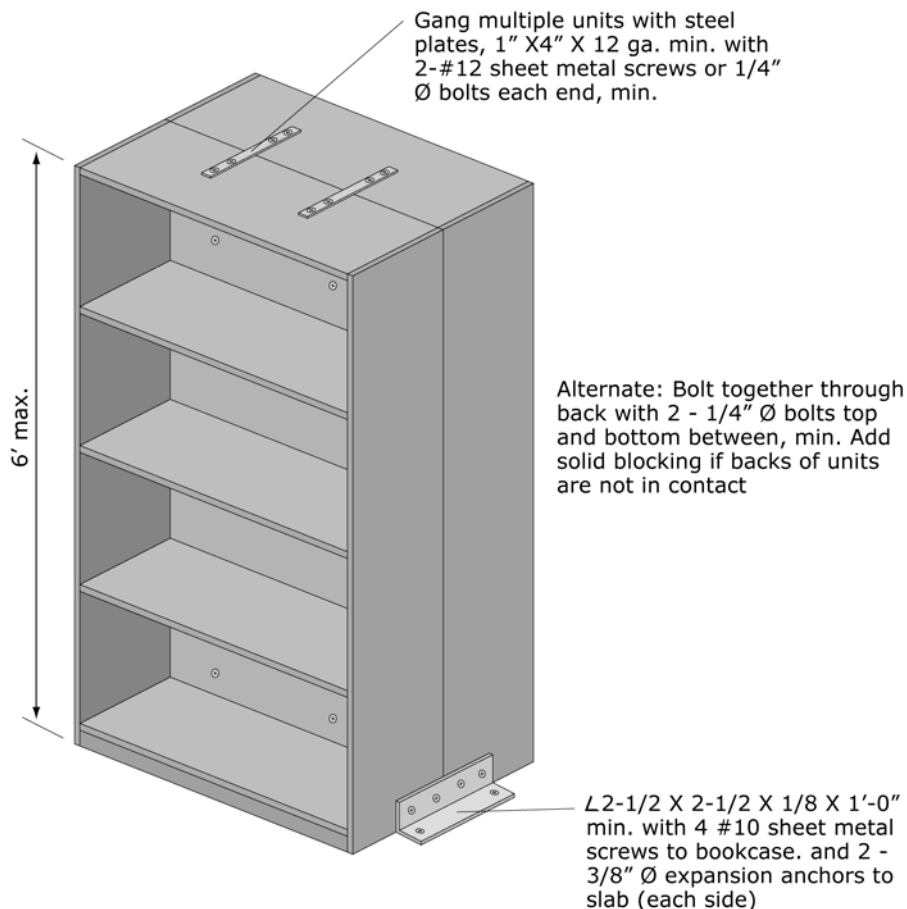


Figure 6.5.2.1-4 Bookshelves against wall (NE, ER).



Note: Engineering required for all permanent floor-supported cabinets or shelving over 6 feet tall. Details shown are adequate for typical shelving 6 feet or less in height.

Figure 6.5.2.1-5 Anchorage of freestanding book cases arranged back to back (NE, ER).

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.2 BOOKCASES, SHELVING

6.5.2.2 LIBRARY AND OTHER SHELVING

Library shelving typically consists of many rows of tall back-to-back shelving units that are heavily loaded. There have been many costly failures of library shelving in earthquakes; this includes failures of both unrestrained and poorly restrained shelving units.

TYPICAL CAUSES OF DAMAGE

- Unrestrained or poorly restrained library shelving can slide or overturn resulting in damage to the contents, damage to the shelving units, and damage to partition walls or other contents. Shelving failures may result in personal injuries. It may be costly and time consuming to repair the shelving units and reshelv all of the books.
- Unrestrained or poorly restrained library shelving has failed in a variety of ways. If the base anchorage is inadequate, the bolts can fail and the units may slide or tip. If overhead transverse ties are provided between many shelving units, but no longitudinal bracing or ties are provided, the units may collapse in their longitudinal direction. If undersized transverse ties are provided, or they are attached at the extremes to walls or partitions with insufficient capacity or with inadequate connectors, the units may all topple in their transverse direction like dominos. If individual or back-to-back shelving units are braced to the structure above, these restraints may fail or buckle if they are undersized.
- Damage to rare books or irreplaceable museum collections can be devastating. These materials may need to be rebound or restored at great expense to the institution. Where water leakage from failed sprinkler piping is also an issue, these items may be beyond restoration.

Damage Examples



Figure 6.5.2.2-1 Photo showing collapsed library shelving in the 2010 magnitude-7.1 Canterbury New Zealand Earthquake (Photo courtesy of University of Canterbury).



Figure 6.5.2.2-4 Shelving units with longitudinal ties did not fall over but all of the contents spilled to the floor in the 2010 Canterbury Earthquake. The use of lips or wires would have prevented the damage.(Photo courtesy of University of Canterbury).



Figure 6.5.2.2-3 Longitudinal failure of library shelving units (Photo courtesy of NISEE-PEER, U.C. Berkeley). Transverse ties used to tie units together but this was not enough to prevent longitudinal failure.



Figure 6.5.2.2-2 Failure of overhead transverse bracing for bookshelves were anchored to gypsum board partition in the 1984 magnitude-6.2 Morgan Hill Earthquake (Photo courtesy of Santa Clara County Office of Emergency Services). The anchors were not attached to wall studs, only to gypsum board.



Figure 6.5.2.2-5 These shelving units remained in place but all of the contents spilled in the 2010 magnitude-6.5 Eureka, California Earthquake (Photo courtesy of Steve Mahin, PEER).

SEISMIC MITIGATION CONSIDERATIONS

- Following damage to library collections in the 1994 Loma Prieta Earthquake, the California Library Association developed a library shelving standard, ANSI/NISO Z39.73, *Single-Tier Steel Bracket Library Shelving* (ANSI/NISO, 1994) for single-tier steel bracket library shelving.
- Large library collections may contain rare or valuable items that need to be preserved; such library shelving should be engineered to prevent costly downtime and damage to the collection.
- For new library installations, it is important to procure heavy duty shelving that has cross bracing or solid sides and backing that will prevent longitudinal collapse. In addition, for units that will receive additional overhead bracing, the unit should be strong enough to receive the attached ties and bracing. Light duty steel shelving or weak wood shelving units may require strengthening. Steel shelving may require additional cross bracing. Wood shelving units could be strengthened with the addition of corner brackets or hardware to tie the top, back and sides more securely together.
- Anchor the shelving units to the floor. Where shelving units are located against a structural wall, anchor the top of the units to the structure. Tie freestanding back-to-back units together to create a larger base. A one-way transverse grid or two-way grid may be installed, either at the top of the units or above the ceiling surface, to tie many units together. This grid in turn should be anchored to structural walls at the perimeter of the grid or to the structural slab or framing above.
- Any connections to stud walls must engage the structural studs. Stud walls and partitions typically do not have adequate lateral capacity to support many shelving units unless they have been engineered with heavy gauge studs and braced to resist the imposed lateral loading from the shelving. Anchorage to structural concrete or masonry walls is preferred.
- The location of the library shelving will influence the design loading. Floor accelerations typically increase as you go higher in a building and may also be higher at locations such as poorly braced mezzanine floors.
- See Section 6.5.6.1 for recommendations regarding edge restraints and the arrangement of shelf-mounted items. Especially rare or valuable items may need to be stored in well-anchored temperature controlled and water tight cabinets to protect them from deterioration, dust, sprinkler damage, or from falling.
- Do not locate shelving adjacent to doors or exits if their failure would block the exit.

Mitigation Examples



Figure 6.5.2.2-6 Examples of struts and hardware used to retrofit library shelving at the University of California, Berkeley (Photos courtesy of Mary Comerio, Dept. of Environmental Design, University of California Berkeley).

Strut w/ expansion bolts

(E) deck + fill

Strut

1 1

Angle fitting w/ carriage bolt to diagonal brace, typical each end

Adjustable brace fitting

Strut brace, typical

Optional "dust cover" to conceal bracing

Strut w/ 4 carriage bolts up through cabinet

Channel nut

Strut

Bolt

Cabinet top

(E) deck w/ fill or concrete slab

Embedded expansion anchors, typical

Threaded rod w/ stiffener

Strut w/ MB each strut

Figure 6.5.2.2-7 Concealed overhead restraints for library and other shelving (ER).

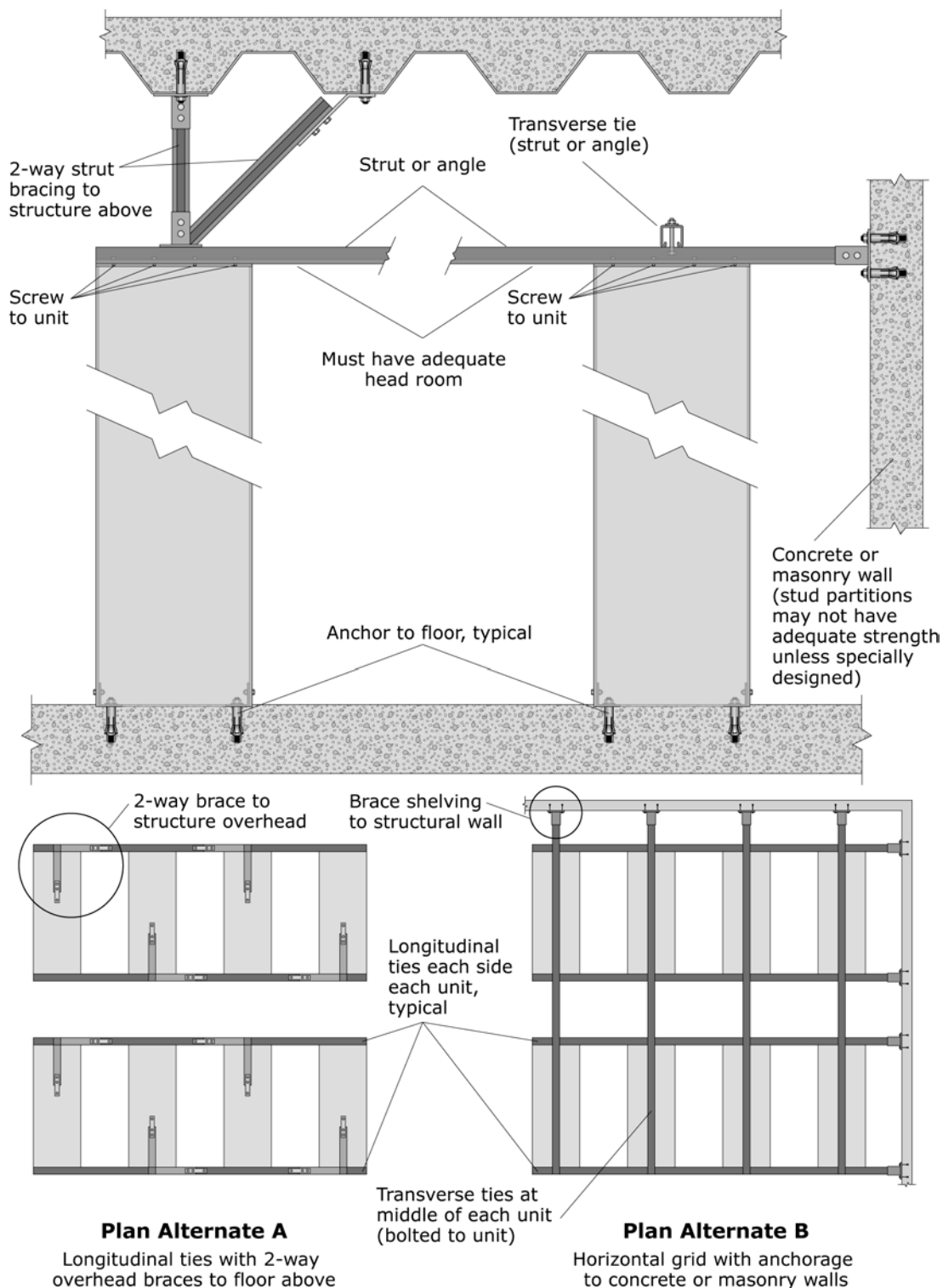


Figure 6.5.2.2-8 Overhead restraints for library and other shelving (ER).

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.3 COMPUTER AND COMMUNICATION EQUIPMENT

6.5.3.1 COMPUTER ACCESS FLOORS AND EQUIPMENT

Computer access floors are raised floor systems used in many facilities with heavy use of computer equipment; these provide space to run the equipment cables under the flooring.

TYPICAL CAUSES OF DAMAGE

- Access floors may collapse if not adequately braced and anchored.
- Equipment located on access floors that are not anchored or tethered may slide and hit a wall or other equipment and may suffer internal damage. Equipment castors can get lodged in floor openings.

Damage Examples



Figure 6.5.3.1-1 Temporary bracing for access floor collapsed in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Wiss, Janney, Elstner Associates).



Figure 6.5.3.1-2 Damage to access floor with short anchored pedestals in the 2010 magnitude-6.7 Chile Earthquake; floor did not have lateral bracing. Note many tiles misaligned (Photos courtesy of Antonio Iruretagoyena, Rubén Boroschek & Associates).



Figure 6.5.3.1-3 Undamaged access floor with braced pedestals in the 2010 Chile Earthquake (Photo courtesy of Rodrigo Retamales, Rubén Boroschek & Associates).

SEISMIC MITIGATION CONSIDERATIONS

- ASCE 7–10, *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2010), requires that access floors be designed as architectural components; Section 13.5.7.2 identifies the requirements for “special access floors.” For areas of high seismicity, the hazard to the flooring and associated equipment can be reduced by purchasing and installing systems meeting the requirements for special access floors.
- Access floor base pedestals should be anchored to the floor slab; taller pedestals may also need diagonal bracing. In zones of low or moderate seismicity, or where the floor height is less than 12 inches high, it may be feasible to adhere the pedestals to the floor slab rather than anchoring them. Check the internet for vendors who supply access floors with a seismic capacity rating.
- Equipment placed on access floors should be tethered; heavy equipment should be anchored to structural slab below. Anchorage may be accomplished through installation of an independent frame beneath the equipment. Alternatively, the equipment may be anchored to properly designed access floor framing, or supplemental bracing components.
- If unrestrained equipment on castors is present, cable openings through access floor should have lips to prevent the wheels from getting stuck.
- Proprietary base isolation systems are also available. The equipment is anchored to the isolation base and the isolation base is anchored to the structural slab.

Mitigation Examples



Figure 6.5.3.1-4 Raised floor braced with strut (Photo courtesy of Maryann Phipps, Estructure).



Figure 6.5.3.1-5 Data rack bolted through access floor to supplemental strut bracing below (Photo courtesy of Maryann Phipps, Estructure).

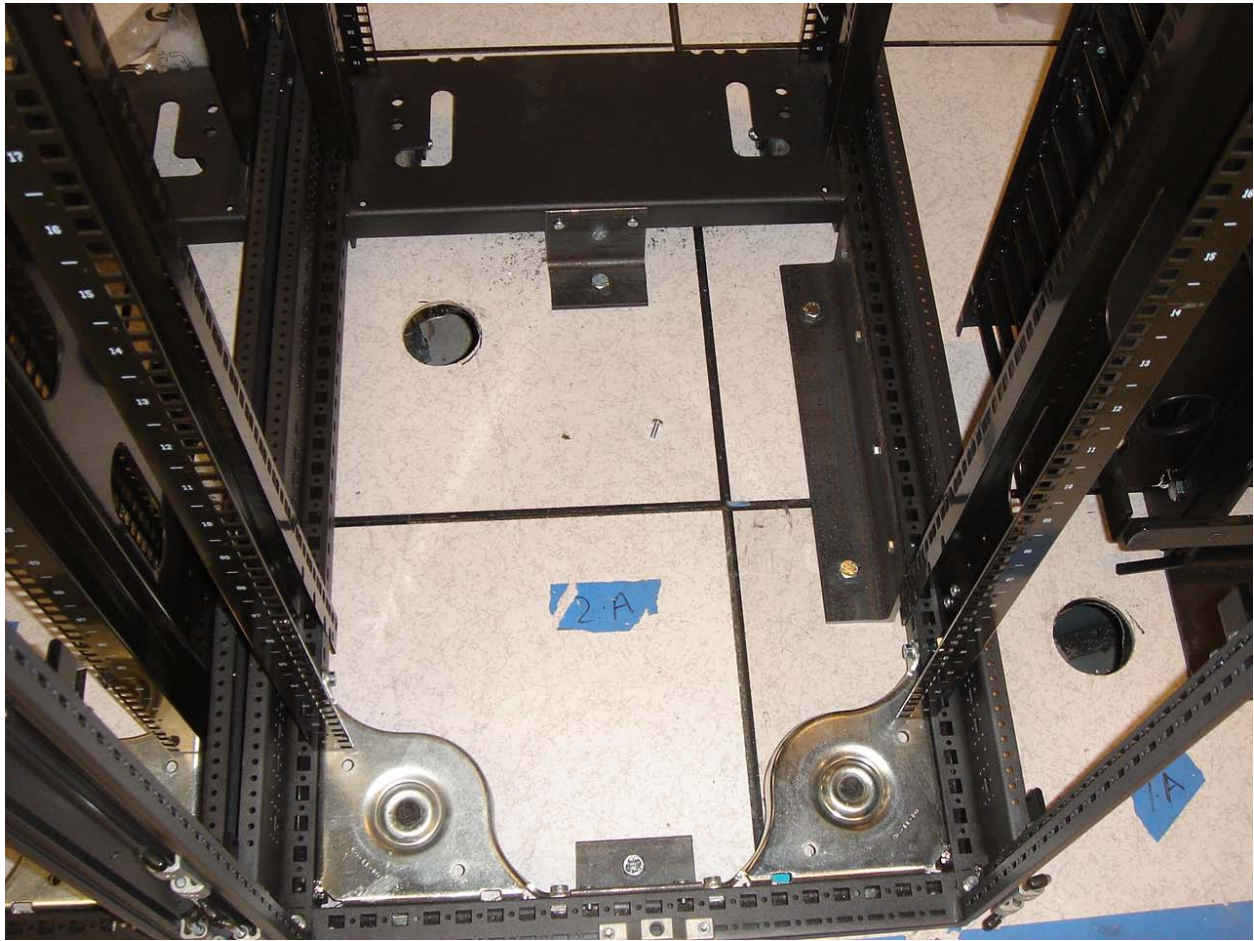


Figure 6.5.3.1-6 Base of data cabinet with supplemental angles bolted to strut bracing below floor (Photo courtesy of Maryann Phipps, Estructure).

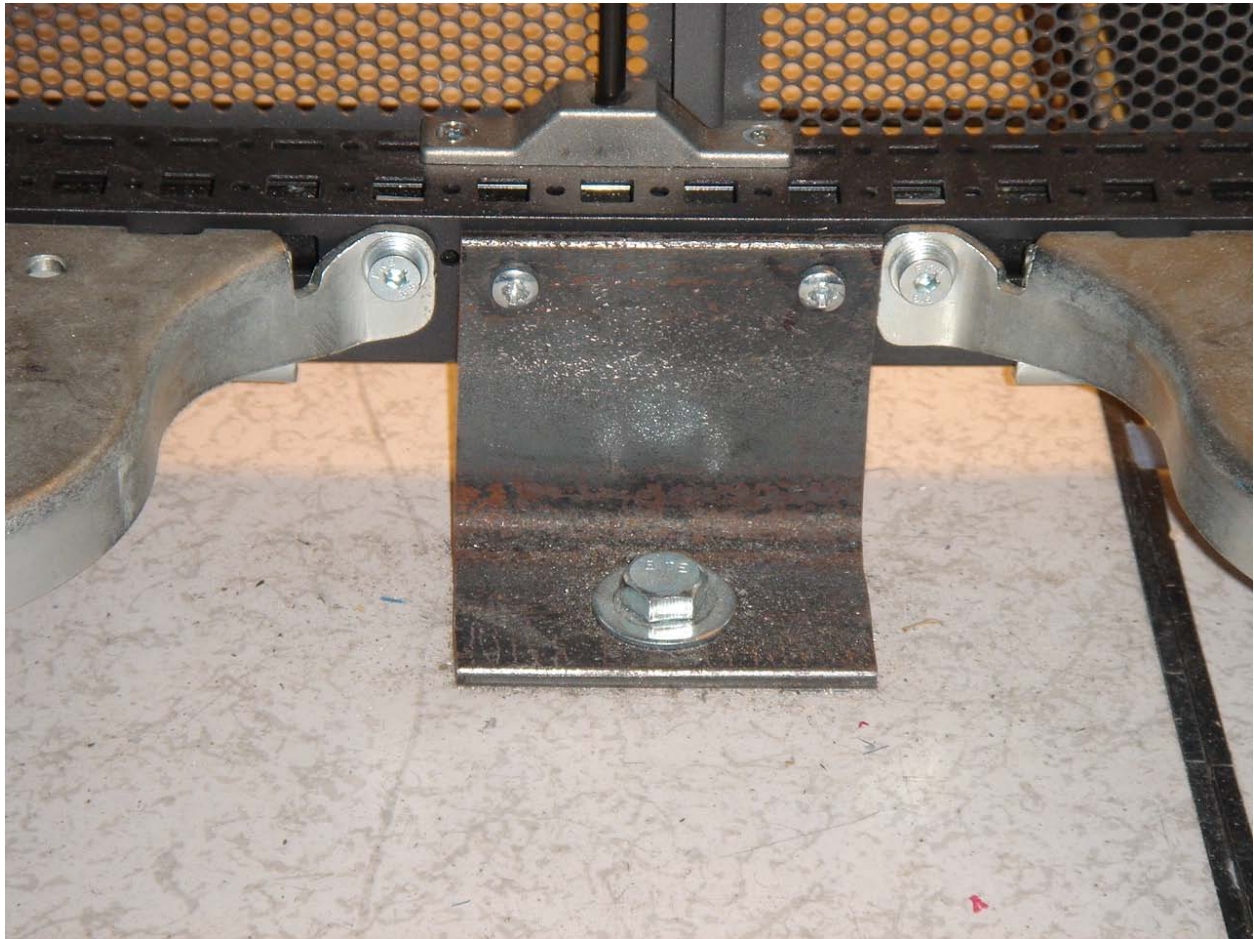
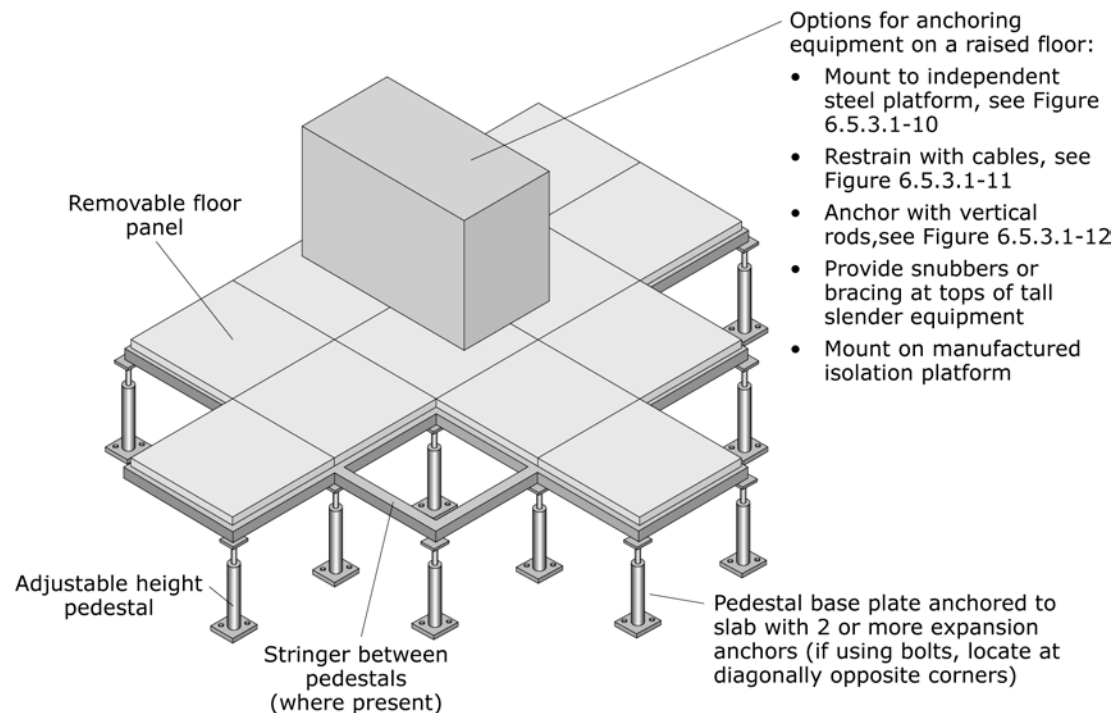


Figure 6.5.3.1-7 Close-up of supplemental angles connecting data cabinet to strut bracing below floor (Photo courtesy of Maryann Phipps, Estructure).

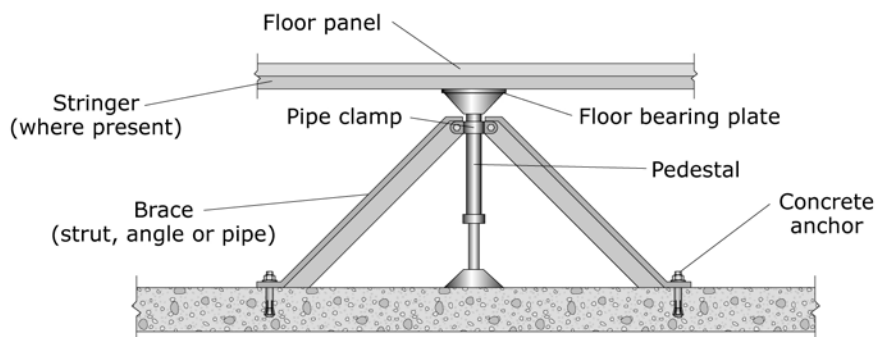


Figure 6.5.3.1-8 Strut framing added to brace data cabinet located on access floor. Bolts from angles above are connected to strut framing below (Photo courtesy of Maryann Phipps, Estructure).

Mitigation Details



Cantilevered Access Floor Pedestal

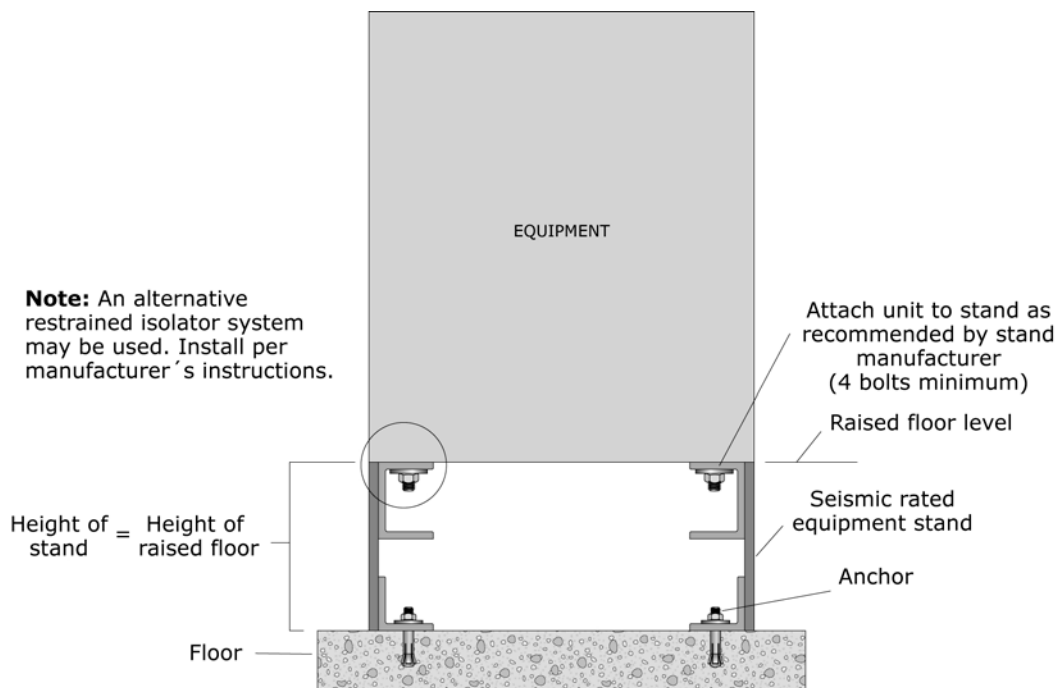


Braced Access Floor Pedestal

(use for tall floors or where pedestals are not strong enough to resist seismic forces)

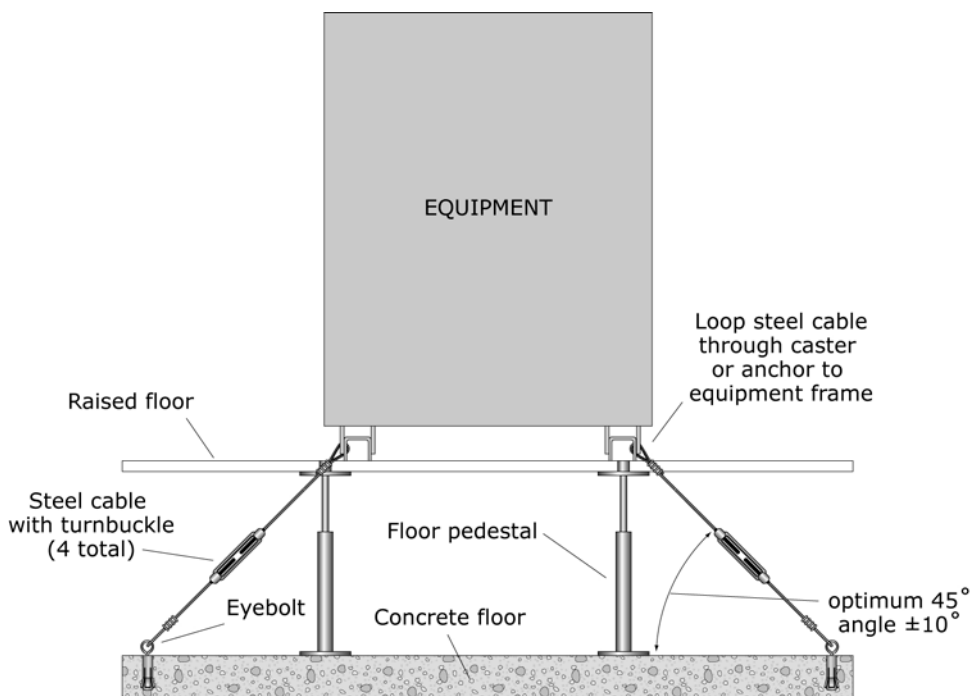
Note: For new floors in areas of high seismicity, purchase and install systems that meet the applicable code provisions for "special access floors."

Figure 6.5.3.1-9 Equipment mounted on access floor (ER).



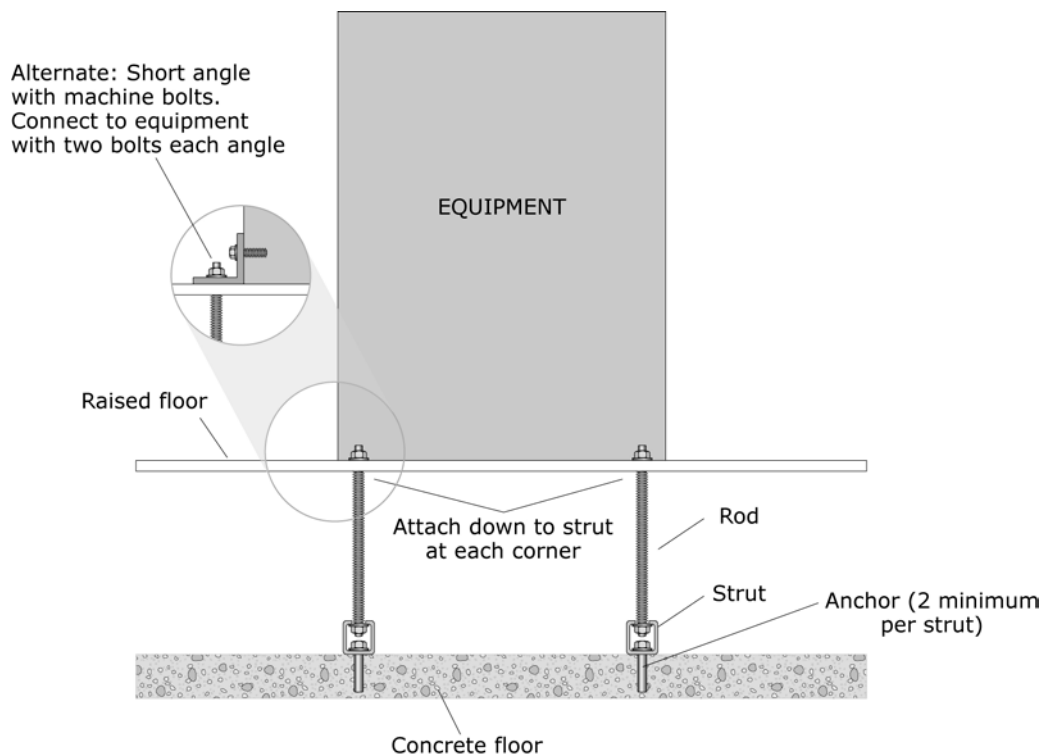
Equipment installed on an independent steel platform within a raised floor

Figure 6.5.3.1-10 Equipment mounted on access floor - independent base (ER).



Equipment restrained with cables beneath a raised floor

Figure 6.5.3.1-11 Equipment mounted on access floor – cable braced (ER).



Equipment anchored with vertical rods beneath a raised floor

Figure 6.5.3.1-12 Equipment mounted on access floor – tiedown rods (ER).

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.3 COMPUTER AND COMMUNICATION EQUIPMENT

6.5.3.2 COMPUTER AND COMMUNICATION RACKS

Steel racks for servers or communications equipment may be open or closed, wall or floor mounted or portable. To prevent damage and loss of communication links, racks should be braced, anchored, or tethered with equipment firmly secured to the rack and cables arranged with adequate slack.

TYPICAL CAUSES OF DAMAGE

- Unbraced, unanchored, or poorly anchored racks can slide, tip, overturn or collapse. Equipment may slide, bang, or fall and suffer internal damage; cable connections may pull loose and get scrambled.

Damage Examples



Figure 6.5.3.2-1 Damage to communication and computer racks (Photo courtesy of Degenkolb Engineers).

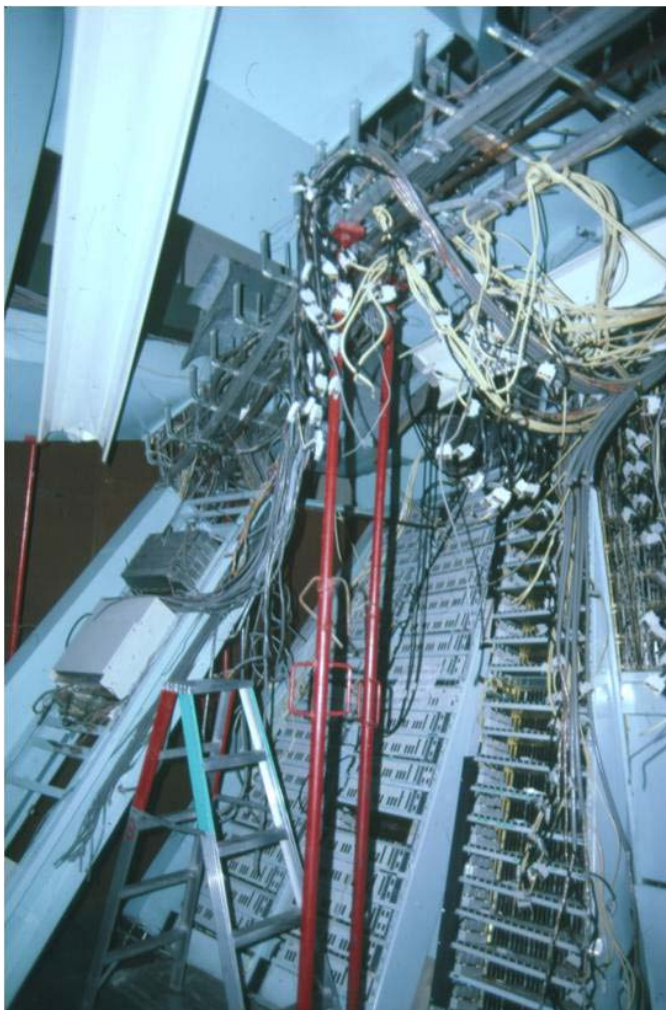


Figure 6.5.3.2-2 Damage to communication and computer racks (Photo courtesy of Degenkolb Engineers).

SEISMIC MITIGATION CONSIDERATIONS

- Check suppliers for seismic rated cabinet racks or server racks that come with predrilled holes and hardware for floor or wall anchorage. Where items are anchored to a partition wall, make sure that the wall and wall anchorage or bracing to the structure above are adequate to resist the imposed loads. Cables and wiring should be installed with sufficient slack to allow for some seismic deformations.
- See also Section 6.5.3.1 for equipment on access floors; see Section 6.4.7.1 for details for anchorage of electrical cabinets. Also refer to FEMA 413, *Installing Seismic Restraints for Electrical Equipment* (2005), for general guidelines for anchorage of electrical items.
- Develop a backup and recovery plan for all electronic data including offsite backup to a location not likely to be affected by the same earthquake.

Mitigation Examples



Figure 6.5.3.2-3 Base anchorage details for data cabinets; top photos shows internal anchorage, bottom photo shows external anchorage (Photos courtesy of Maryann Phipps, Estructure).

Mitigation Details

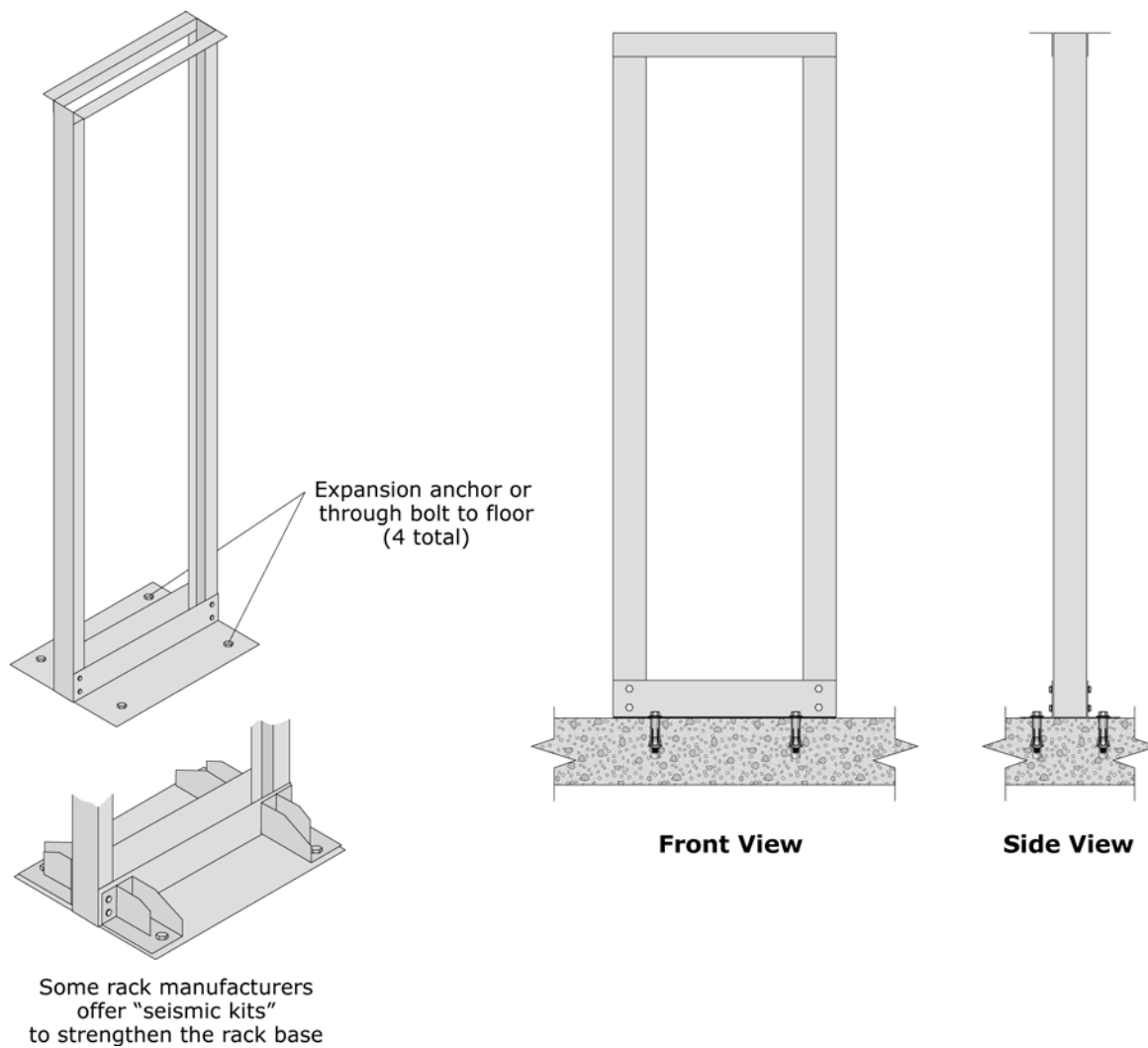


Figure 6.5.3.2-4 Data rack (ER).

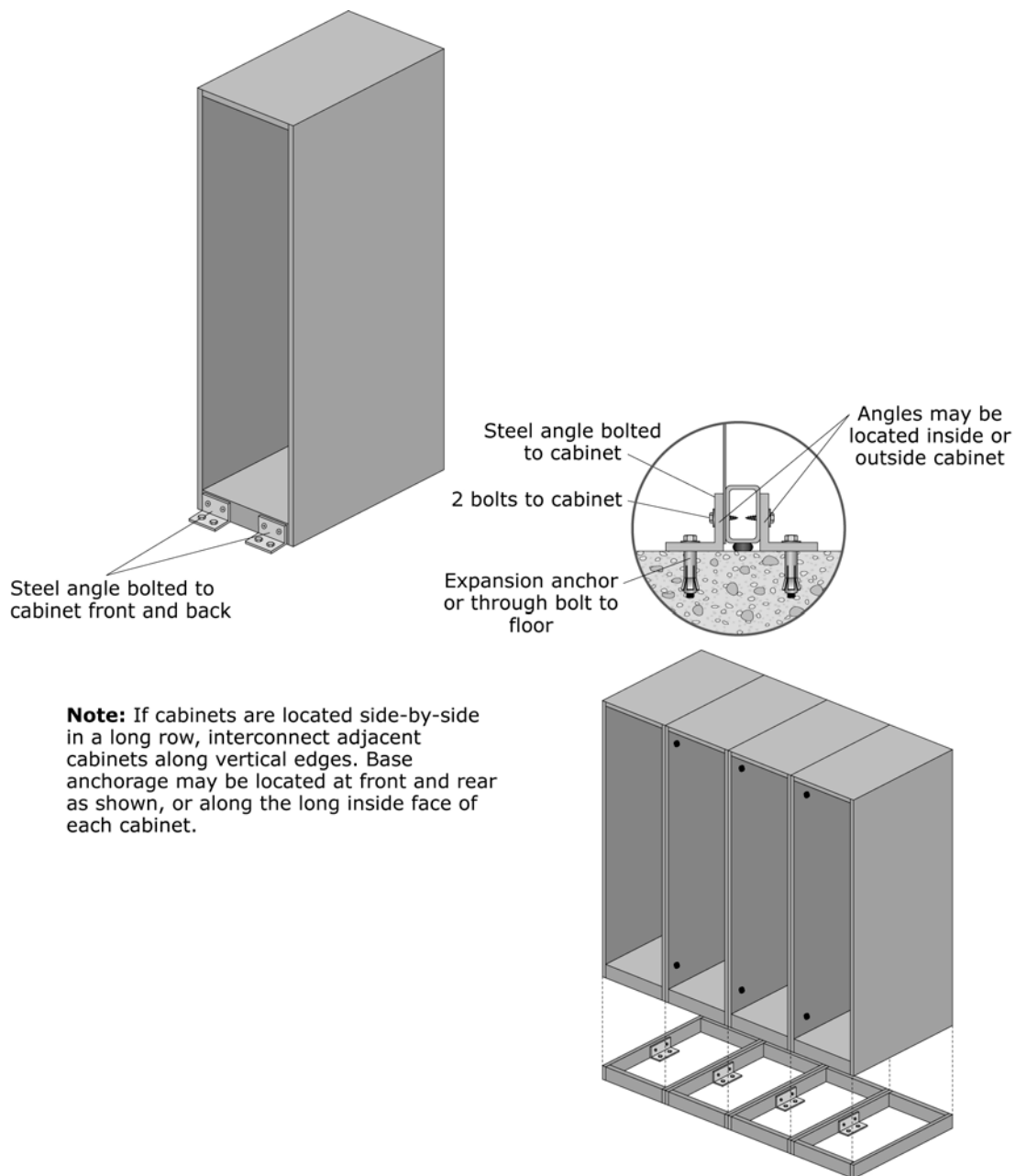


Figure 6.5.3.2-5 Data cabinet (ER).

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.3 COMPUTER AND COMMUNICATION EQUIPMENT

6.5.3.3 DESKTOP COMPUTERS AND ACCESSORIES

Computers, printers, monitors, projectors, scanners and other electronic equipment are found nearly everywhere, most of them resting on desks and tables without restraint.

TYPICAL CAUSES OF DAMAGE

- Desktop items may slide, tip, collide with other items or fall. If one item falls, the cords and cables may pull other items down resulting in additional damage.
- Equipment may suffer internal damage and be rendered inoperable. Business interruption losses may result.

Damage Examples



Figure 6.5.3.3-1 Computer monitor slid off desktop onto floor in the 2010 magnitude-6.5 Eureka, California Earthquake (Photo courtesy of Steve Mahin, PEER).



Figure 6.5.3.3-2 Damage to control tower at the SeaTac Airport in the 2001 Nisqually Earthquake (Photo courtesy of JCP Geologists).

SEISMIC MITIGATION CONSIDERATIONS

- Desktop equipment should be anchored or tethered to prevent earthquake damage, loss of equipment and loss of electronic files. The supporting desk, table or cart should also be anchored or tethered if movement could cause additional damage. Alternatively, cables and cords should be installed with sufficient slack to allow for some movement.
- Many proprietary safety fasteners are currently available to use to restrain desktop items. See also Section 6.5.6.2 for tether details.

Mitigation Details

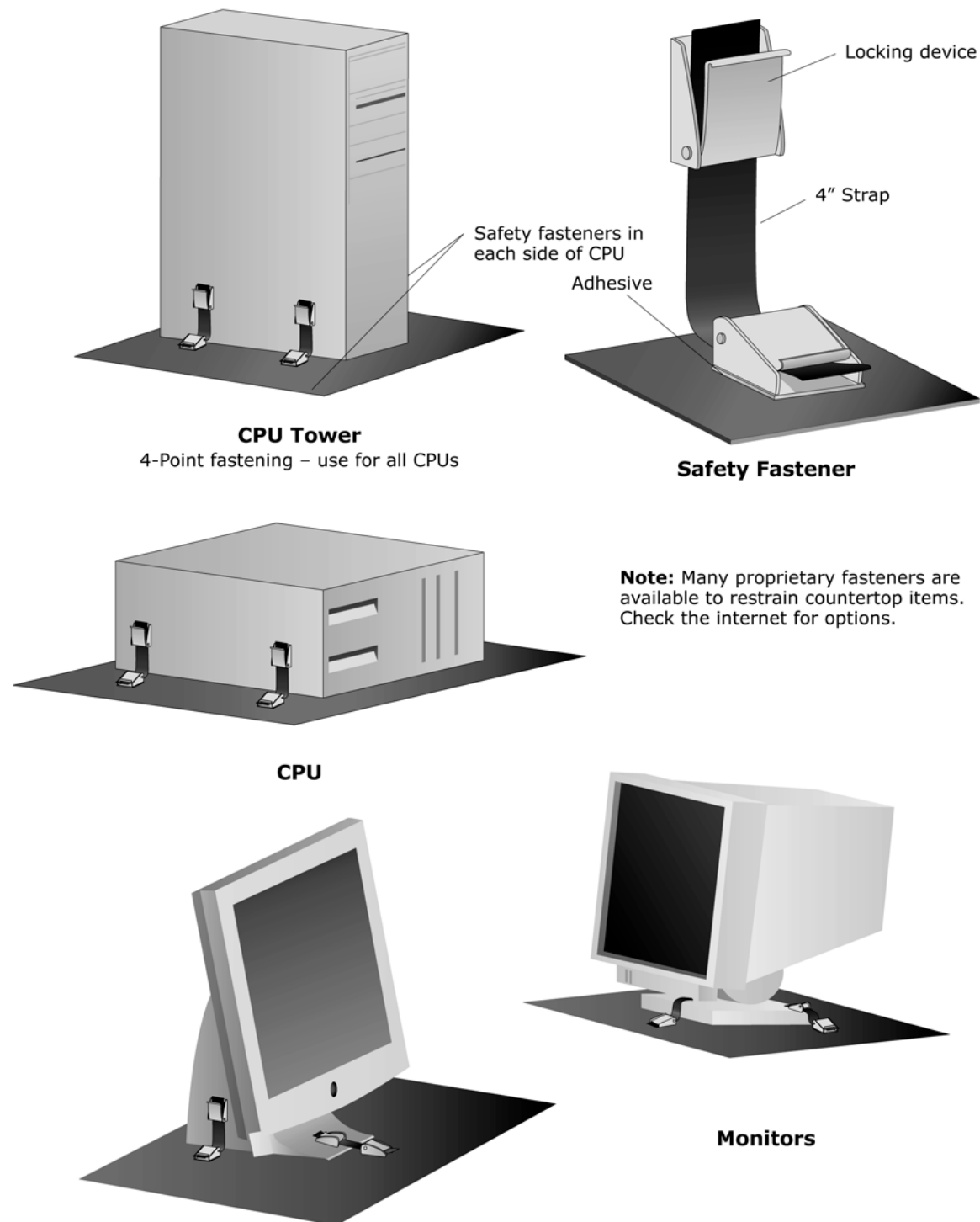


Figure 6.5.3.3-3 Desktop computers and accessories (NE).

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.3 COMPUTER AND COMMUNICATION EQUIPMENT

6.5.3.4 TELEVISIONS AND VIDEO MONITORS, WALL-MOUNTED

Wall and ceiling mounted televisions, monitors and projectors are found in many places including homes, classrooms, airports, and hospital rooms.

TYPICAL CAUSES OF DAMAGE

- These items may shake, bounce, impact adjacent items, or fall. Wall or ceiling-mounted items can become dislodged and fall from the supporting bracket, the bracket could pull out from the wall or ceiling, or the bracket can break and the television or monitor may be damaged or broken.
- These items are heavy and could cause serious bodily injury if they fall on someone.

Existing Condition



Figure 6.5.3.4-1 Wall-mounted monitor fell from the bracket in a hospital in the 2010 magnitude-8.8 Chile Earthquake; bracket still anchored to the wall (Photos courtesy of Rodrigo Retamales, Rubén Boroschek & Associates)

SEISMIC MITIGATION CONSIDERATIONS

- Proprietary video mounting brackets are available to support overhead or wall-mounted televisions, monitors, and screen of all sizes. These come as rigid mount, tilt mount, or motorized mount. Check the internet; some of these products indicate they are seismic rated for safer installations.
- Brackets will not provide seismic protection unless properly installed; follow the manufacturer's installation instructions. It is critical that the lag bolts, screws, or expansion bolts used be installed directly into structural elements such as studs, concrete or masonry wall, or ceiling joists that have adequate capacity to support the additional loading. Do not anchor to gypsum board, plaster or a suspended ceiling grid. See the installation notes in Section 6.6 of this document for more information on anchorage details.
- If the bracket can be adjusted into different positions, make sure it cannot swing and hit a window or light; providing a safety cable or tether to restrict the range of motion may reduce the risk of impact with other objects and the risk of falling.
- Do not locate overhead items directly over a bed, couch, bench, or desk in a classroom where people are likely to be.
- For televisions or monitors resting on furniture or a home entertainment center, heavy-duty safety fasteners or tethers should be used to prevent the television from falling and the furniture should be anchored to the floor or wall.

Mitigation Examples



Figure 6.5.3.4-2 Wall-mounted television bracket anchored with sheet metal screws to wall studs at four locations. Bracket must be rated for the weight of television or monitor and that the unit must be securely attached to the bracket (Photo courtesy of Maryann Phipps, Estructure).



Figure 6.5.3.4-3 Mounting plate above ceiling for overhead television bracket in a hospital room. Television or monitor must be securely attached to the bracket (Photos courtesy of Maryann Phipps, Estructure).

Mitigation Details

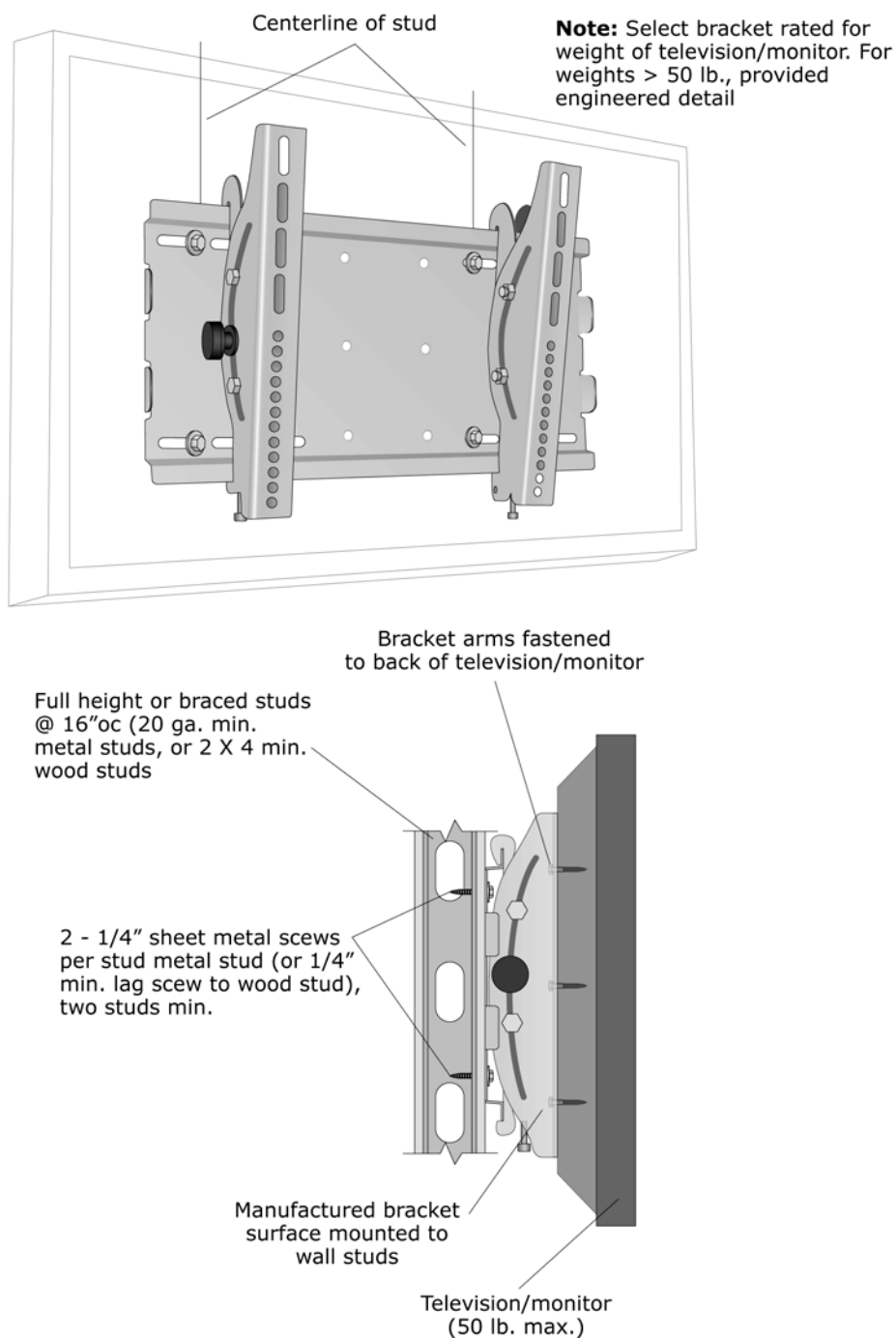


Figure 6.5.3.4-4 Wall-mounted bracket for television or monitor weighing less than 50 lb (NE).

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.4 HAZARDOUS MATERIALS STORAGE

6.5.4.1 HAZARDOUS MATERIALS STORAGE

Unsecured or improperly stored hazardous materials resulting in a release may close businesses located in an otherwise undamaged building. Hazardous materials may include cleaning supplies, laboratory or production chemicals, medical sharps, and biohazard containers. These may be stored in fragile containers or may be in open vats in an industrial setting.

TYPICAL CAUSES OF DAMAGE

- Loose containers may slide, tip, overturn, or fall. Glassware may break; hazardous contents may slosh or spill and create noxious fumes and toxic mixtures.
- Spilled flammable liquids may cause a fire and destroy a home or business that otherwise may have survived an earthquake without damage.
- Unknown spills may cause building closure until a HAZMAT team can investigate.

Damage Examples



Figure 6.5.4.1-1 Spilled chemicals in high school chemistry lab in the 1971 magnitude-6.6 San Fernando Earthquake (Photo courtesy of EERI).



Figure 6.5.4.1-2 Spilled pharmaceutical and medical supplies in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Robert Reitherman).



Figure 6.5.4.1-3 Spilled fluids in a hospital in the Costa Rica Earthquake (Photo courtesy of Degenkolb Engineers).



Figure 6.5.4.1-4 Fire destroyed the chemistry building containing the entire chemistry department at the University of Concepción in the 2010 magnitude-8.8 Chile Earthquake; fire exacerbated by the presence of hazardous chemicals (Photo courtesy of Bill Holmes, Rutherford & Chekene).

SEISMIC MITIGATION CONSIDERATIONS

- ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2010), Sections 13.1.3.1 and 13.1.3.4 require that any component that conveys, supports or contains toxic, highly toxic or explosive materials above a threshold quantity or a component that conveys, supports, or contains hazardous substances that is attached to a structure classified as a hazardous occupancy be considered a designated seismic system with a component importance factor, I_p , of 1.5. These items may require engineering calculations, special certification, and additional inspections. See ASCE 7-10 for additional requirements.
- The National Fire Protection Association (NFPA), the International Building Code, and the International Fire Code (IFC) contain many requirements pertaining to the classification, labeling, handling, monitoring, shipping, containment, and storage of hazardous

materials. Check the applicable jurisdiction for requirements. See also the discussion of hazardous materials piping in Section 6.4.5.1.

- Hazardous materials storage cabinets and lockers are available with secure door closures and internal containment in case materials spill inside the cabinet. Brace and anchor all shelving units or cabinets used for storage of hazardous materials. See Section 6.5.1.1 and 6.5.2.1 for restraint details. Where shelving or cabinets are anchored to a partition wall, check that the partition, bracing and attachments to the structure above are adequate for the imposed loads.
- See Section 6.5.6.1 for recommendations for edge restraints and arrangement of shelved items. Provide edge restraints for containers of flammable or hazardous substances even if they are in closed cabinets.
- Secure large containers of production chemicals or cleaning supplies; these may be secured using tether cables or chains. See Section 6.4.2.3 or Section 6.5.5.3 for similar restraint details.
- Store small or breakable items in original packaging or in “egg crate” type boxes; not loose on shelves or in drawers.
- Ensure that all toxic items are in the correct containers and properly labeled.
- Ensure that employees know what to do in case of a spill. Make sure they know where to find the Material Data Safety Sheets (MSDS). The MSDS contains physical data for chemicals, chemical compounds and chemical mixtures and provides information for workers and emergency personnel regarding the safe use and potential hazards of each product. The MSDS includes information such as melting point, boiling point, flash point, reactivity, toxicity, health effects, protective equipment required, first aid procedures, storage and disposal procedures, spill-handling procedures, and labeling requirements. Facilities that use or store chemicals should have an MSDS for each product on site; employees should know where to locate the MSDS binder and know what steps to take in case of a spill.
- Store incompatible materials at a safe distance from each other to avoid mixing if the containers fall and break.
- Order hazardous lab chemicals in unbreakable plastic bottles or in glass bottles with an exterior plastic safety coating.
- Keep all large containers or vats of toxic, hot, or hazardous items covered to prevent surging in an earthquake.

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.5 MISCELLANEOUS FURNITURE, FIXTURES AND EQUIPMENT

6.5.5.1 FILE CABINETS

Sheet metal file cabinets are often tall, narrow and heavily loaded. These cabinets frequently overturn in earthquakes; the time required to pick up and reorganize files may be significant business expense and result in lost productivity.

TYPICAL CAUSES OF DAMAGE

- Unanchored file cabinets can slide, tip, or overturn. Drawers may slide open increasing the chance that the cabinet will overturn; contents may fall and get scrambled.
- Overturned cabinets may block doors and exit corridors.

Damage Examples



Figure 6.5.5.1-1 Failure of file cabinets in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Wiss, Janney, Elstner Associates).



Figure 6.5.5.1-2 Tipped filing cabinets and other office equipment at the Lawrence Livermore Lab, California (NGDC, 2009).



Figure 6.5.5.1-3 Unanchored cabinets toppled in the 1994 Northridge Earthquake (Photo courtesy of Wiss, Janney, Elstner)

SEISMIC MITIGATION CONSIDERATIONS

- ASCE 7–10, *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2010), requires that permanent floor supported cabinets or shelving over 6 ft tall be treated as architectural components. This requirement does not apply to wall mounted items with both base and wall anchorage.
- Do not locate cabinets where their failure would block a door or exit corridor; note some school districts do not allow file cabinets within 6 feet of a doorway. Do not locate where they could fall and break a window or glass partition.
- File cabinets should be anchored to the floor or wall. Where cabinets or shelving are anchored to a partition, check that the partition, bracing and attachment to the structure above are adequate for the imposed loading.
- Adjacent freestanding file cabinets should be anchored together and to the floor. Gang multiple units together to create a more stable arrangement.
- Provide strong drawer latches to prevent the drawers from sliding open. Fluids and files don't mix; do not place flower vases or other breakable fluid containers on top of file cabinets.
- There are many acceptable ways to reliably protect file cabinets from earthquake damage. The following details illustrate measures that can protect loaded cabinets up to 6 ft tall in severe ground shaking at the highest locations within a building; engineering may be required for floor-supported items taller than 6 feet. Alternate less robust details may be developed for less severe loading conditions.

Mitigation Details

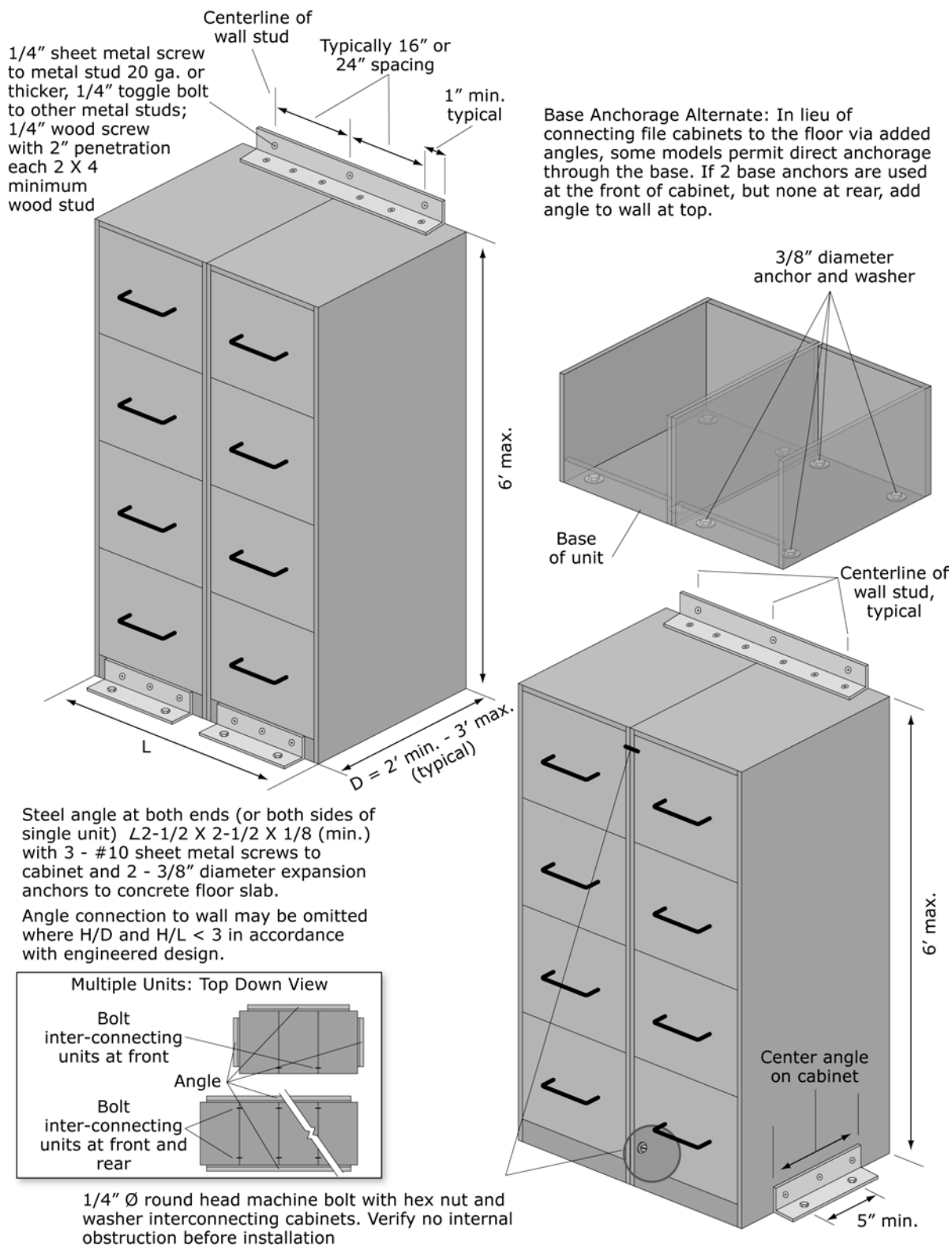


Figure 6.5.5.1-4 Wall-mounted file cabinets (NE).

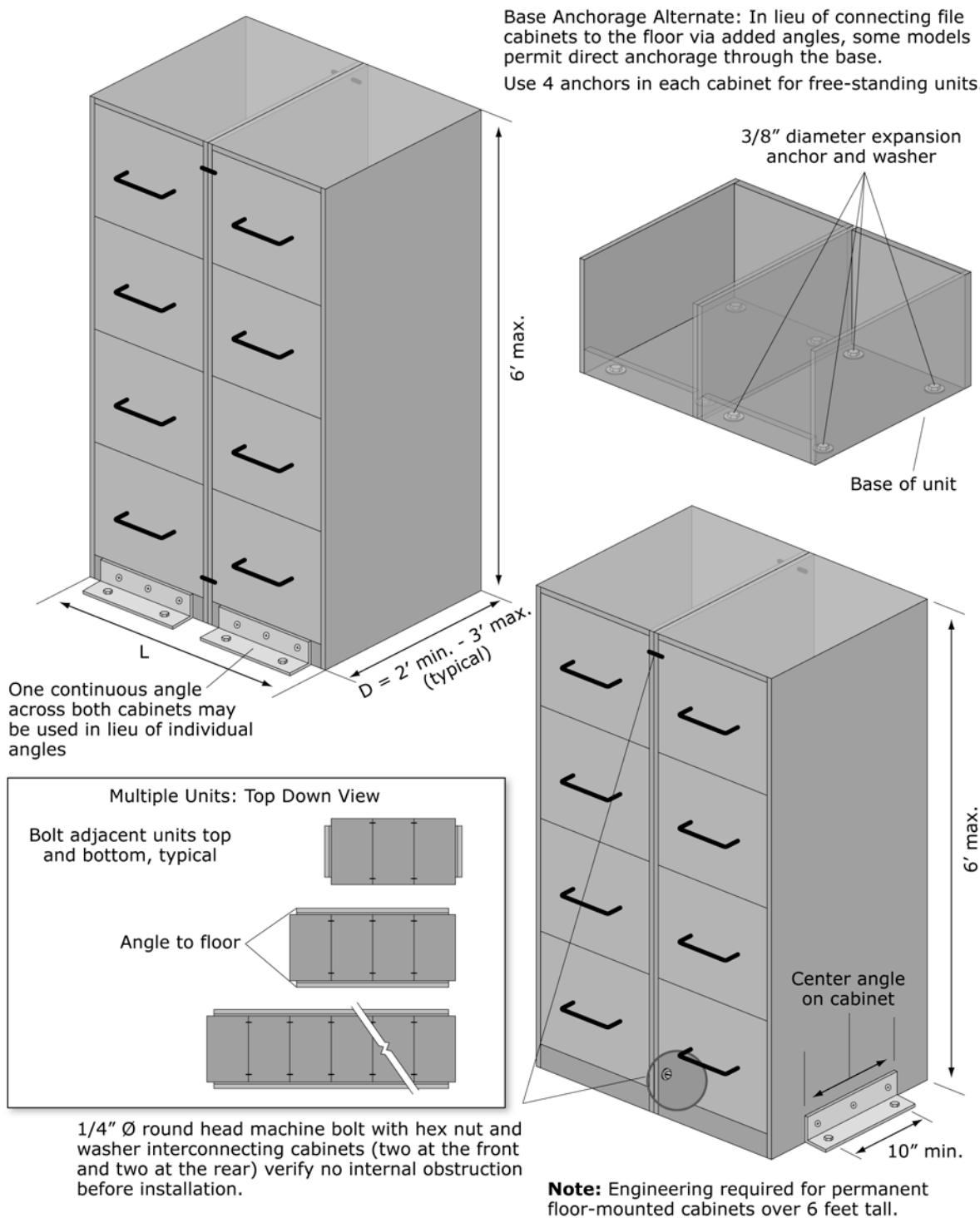


Figure 6.5.5.1-5 Base-anchored file cabinets (NE).

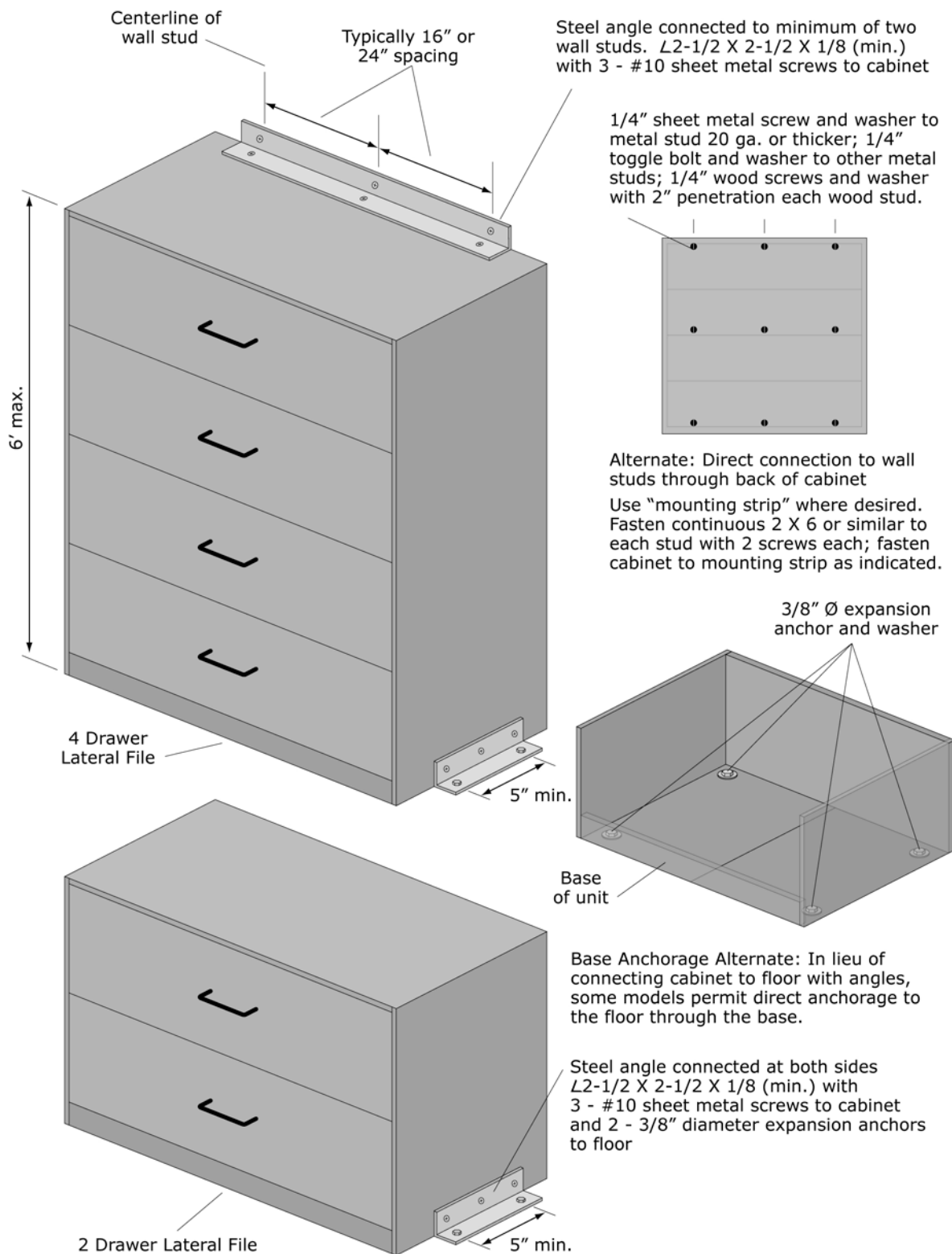


Figure 6.5.5.1-6 Wall-mounted and base-anchored lateral file cabinets (NE).

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.5 MISCELLANEOUS FURNITURE, FIXTURES AND EQUIPMENT

6.5.5.2 DEMOUNTABLE PARTITIONS

These are freestanding half-height partition walls that are often used to delimit office work spaces. These partitions are typically installed by tenants or occupants and may be readily relocated.

TYPICAL CAUSES OF DAMAGE

- Long runs of unbraced panels are vulnerable to falling over if not specially detailed.
- Partitions that support overloaded shelving units are particularly vulnerable.

Damage Examples



Figure 6.5.5.2-1 Damage to demountable partitions at the Veterans Administration Medical Center in Sepulveda as a result of the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of James O. Malley).



Figure 6.5.5.2-2 Damage to unbraced demountable partition in Silicon Valley office building in the 1989 magnitude-6.9 Loma Prieta Earthquake (Photo courtesy of Maryann Phipps, Estructure).

SEISMIC MITIGATION CONSIDERATIONS

- Check the internet for demountable partitions with seismic rated capacity; some of these have been shake table tested and have improved seismic detailing.
- Panel manufacturers typically have guidelines for acceptable panel configurations for use in earthquake prone areas. Shorter runs of panels with panels at 90 degrees to one another provide favorable conditions for earthquake resistance. Panel anchorage at the base and interconnectivity between panels is also needed for reliable performance. Where panels are not stabilized by return panels, or where panels are tall, bracing at the tops of the panels, up to the structural framing, may be required. Anchorage to the floor slab is another alternative as shown in Figure 6.5.5.2-4.

Mitigation Details

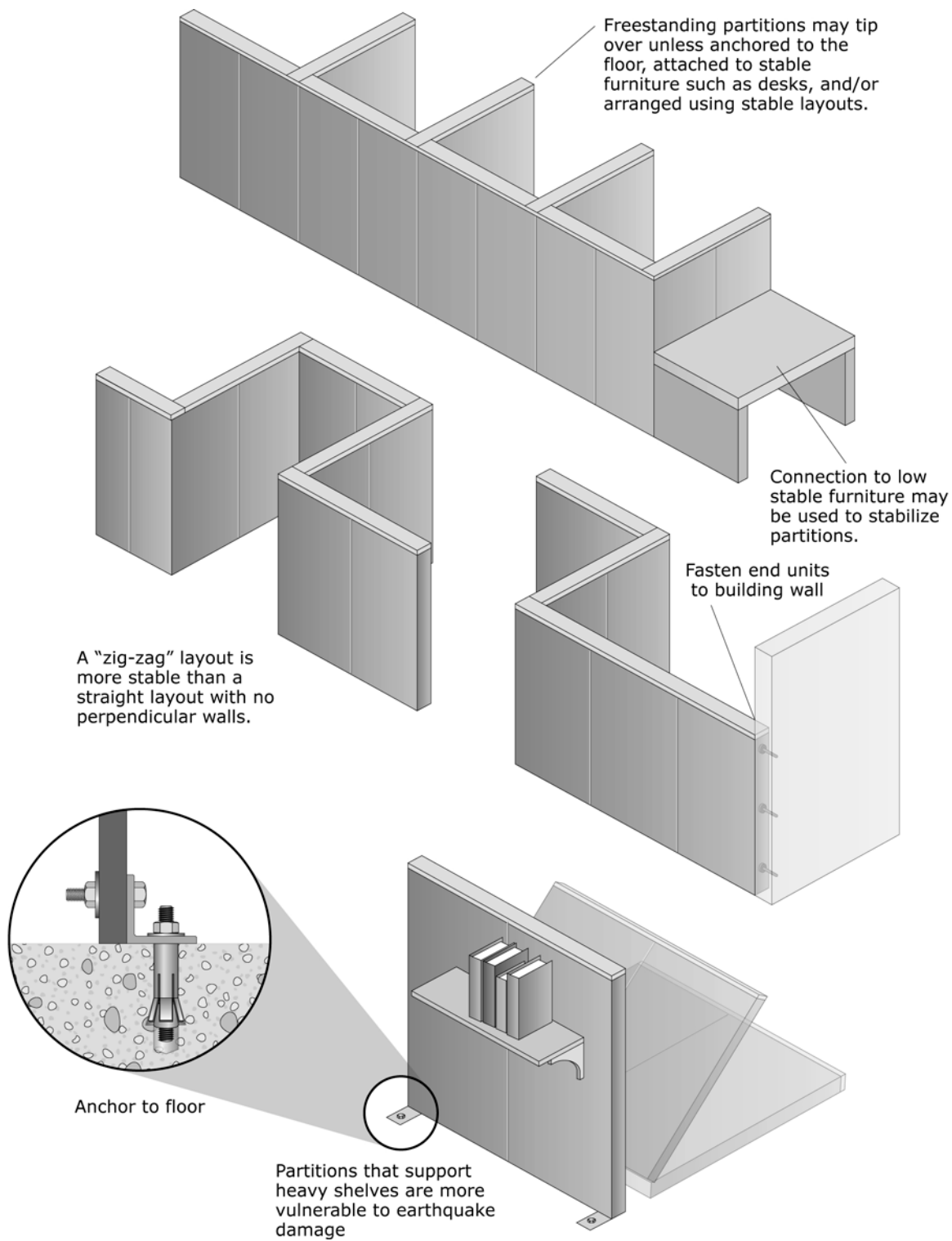


Figure 6.5.5.2-3 Demountable partitions (NE).

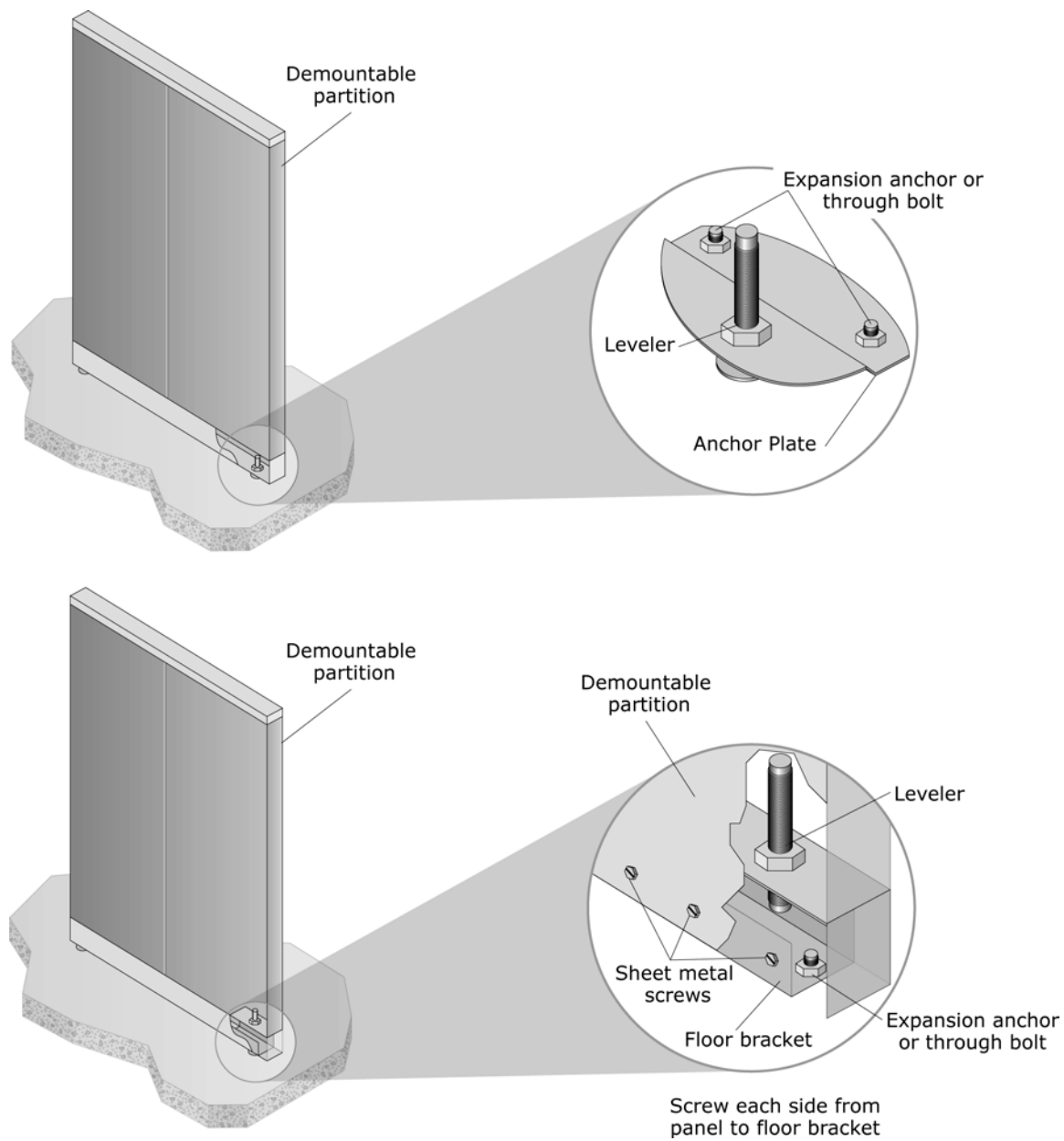


Figure 6.5.5.2-4 Demountable partition details (NE).

6.5 FURNITURE, FIXTURES, EQUIPMENT AND CONTENTS

6.5.5 MISCELLANEOUS FURNITURE, FIXTURES AND EQUIPMENT

6.5.5.3 MISCELLANEOUS FURNITURE AND FIXTURES

Furniture and fixtures come in all shapes and sizes. Items on castors will roll; squat items are likely to slide; medium height items may slide, rock back and forth, or overturn; tall narrow furniture is likely to overturn. This category provides general recommendations for a wide range of items such as shop and kitchen equipment, vending machines, large office copiers, pianos, china hutches, and entertainment centers.

TYPICAL CAUSES OF DAMAGE

- Unrestrained items may slide, impact other items, tip, and/or overturn. Failure of one item may damage others or cause the collapse of other items.
- Contents supported on furniture or fixtures may fall, break, or spill.

Damage Examples



Figure 6.5.5.3-1 Residential damage in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Wiss, Janney, Elstner Associates).



Figure 6.5.5.3-2 Existing condition: Unrestrained kitchen equipment (Photo courtesy of EQE for the Salt Lake City School District).



Figure 6.5.5.3-3 Equipment on wheels did well during the 2010 magnitude-8.8 Chile Earthquake; there were no reported injuries or examples of overturning related to equipment mounted on wheels. Centrifuges on wheels shown in photo (Photo and information courtesy of Bill Holmes, Rutherford & Chekene).

SEISMIC MITIGATION CONSIDERATIONS

- Many proprietary items are available to restrain a wide variety of furniture and fixtures. Check the internet for seismic safety fasteners and security restraints.
- Provide floor or wall anchorage for vulnerable items, especially items near doors, exits, beds or other locations where people spend many hours. Anchor freestanding items together and to the floor. Provide tethers for items like kitchen equipment, vending machines, or grand pianos. Provide edge restraints and drawer and cabinet latches.
- Canvas or metal straps can be used to attach some items where it is not acceptable to penetrate the furniture or housing. Multiple tethers may be needed for strength and stability; for instance a tether to only one leg of a grand piano may pull the leg off.

- Where several items need to be tethered and the edges do not line up with studs in the adjacent wall, a continuous steel angle or wood 2x4 may be attached to the wall and then the tether restraints in turn attached to the steel angle wood stud. Where items are attached to partitions, verify that the partition and attachment or bracing to the structure above are adequate for the imposed loading.

Mitigation Examples



Figure 6.5.5.3-4 Anchored wood key cabinets in industrial plant control room; note top and bottom units anchored together and both anchored to wall (Photo courtesy of Eduardo Fierro, BFP Engineers).



Figure 6.5.5.3-5 Typical tethering details for kitchen equipment and vending machines. Tether provided on both sides of equipment and does not penetrate the equipment housing (Photos courtesy of Maryann Phipps, Estructure).